Multilayered coding supports migration to new standard

FIELD OF THE INVENTION

The invention relates to a method of supplying encoded content data such as audio, video, multimedia, etc. The invention also relates to software for implementing a decoder for decoding encoded data representative of content information, and to an electronic device comprising a decoder for decoding encoded data representative of content information. The invention relates in particular, but not exclusively, to the field of consumer electronics (CE).

BACKGROUND ART

Multi-layer coding or compression techniques are being used to process content source data in order to create multiple layers of data. The layers are to be overlaid or otherwise combined to regenerate the source data. The layers comprise, for example, a base layer and one or more enhancement layers. Typically, the enhancement layers are used as an option for enhancing the rendering of the content represented in the base layer. Techniques exist that allow a video coding standard, intended or designed for a normal video signal, to be used for coding the enhancement layers. Accordingly, multi-layer compression allows the use of new and more efficient compression techniques while still having a compatible base layer.

SUMMARY OF THE INVENTION

The inventors have realized that multi-layer coding or compression techniques are suitable tools for a service provider, e.g., a video-on-demand service or a cable operator, to facilitate the transition from a first coding or compression standard to a second coding or compression standard, when the first is in the process of getting obsolete. More specifically, the multi-layer coding enables the service to gradually migrate over time from an installed base of receivers to a contingent of next generation receivers.

Therefore, an embodiment of the invention relates to a method of supplying encoded content data. The method comprises enabling to control a circuit to operate in a specific one of multiple operational modes. A first one of the operational modes relates to decoding a base layer of the content data using a first decoding technique and to decoding an enhancement layer of the content data using a second decoding technique different from the

first. Typically, the enhancement layer represents the difference between the base layer signal and the full-content signal. A second operational mode relates to decoding the content data using the second technique. Preferably, the enabling to control comprises providing control data specifying the specific operational mode. In a further embodiment of the invention, the first technique uses a conventional decoding scheme, and the second technique uses a new or emerging standard that is getting to replace the conventional scheme.

Another embodiment of the invention relates to an electronic device comprising a decoder for decoding encoded data representative of content information. The decoder has a first operational mode and a second operational mode. In the first mode the decoder is operative to decode a base layer of the data using a first decoding technique, and to decode an enhancement layer of the data using a second decoding technique different from the first. In the second mode the decoder is operative to decode the data using the second technique. The decoder is controllable to operate in either the first or the second mode.

Yet another embodiment relates to a physical record carrier with data representative of content information. The data comprises the content information encoded in a base layer using a first encoding technique, e.g., based on a conventional standard and an enhancement layer using a second encoding technique, e.g., based on an emerging standard, different from the first. The data also comprises the content information entirely encoded with the second technique.

A rationale for the invention as discussed above is the following. The service provider is faced with a dilemma during the time when the market is transferring from an established standard to an emerging standard: should the service provider supply the same content in different standards, i.e., at least twice, or should the service provider halt any content supply in the conventional standard? By definition, an emerging standard is not yet supported by the majority of receivers out in the field. The first option implies that the provider can only supply part of the content that his/her channel capacity allows. The second option has as a consequence that conventional receivers out in the field are all rendered obsolete at the moment the conventional standard transmissions stop. As a result, some subscribers are not going to be too pleased. In addition, the second option also causes the problem of determining when exactly the transmissions in the conventional standard are to stop. The invention facilitates the transition to a new standard by means of using a layered coding scheme with a base layer and one or more enhancement layers. The base layer is encoded in the conventional standard, the enhancement layers use the emerging standard. As a result, receivers with a conventional decoder are enabled to receive the content in a base

layer quality. Receivers that have both a conventional decoder plus a decoder compliant with the new standard, referred to as hybrids, are capable of processing the complete content, i.e., base plus enhancement layers. When, say after the expected lifetime of the conventional receiver has expired, the service provider transmits content only in the new, now established standard, the hybrids still are capable to process the complete content by switching decoding of all data to the new standard decoder. To the service provider, channel capacity during the transition is efficiently used under the constraints that conventional receivers as well as hybrids are to be capable of receiving content. Furthermore, the hybrids need not be replaced by the time the transmissions in the conventional standard have stopped, which is again a good thing to the subscribers.

The invention is specifically, but not exclusively, relevant to a class of (currently) emerging video coding standards referred to as H.26L (also called MPEG4 part 10, AVC or H.264) that is expected to supersede MPEG-2, MPEG-4 SP or MPEG4 ASP. The H.26L standard comprises elements common to the MPEG standards, and the H.261 and H.263 standards. For background information see, e.g., "Recent Advances in Video Compression Standards", Guy Côté and Lowell Winger, IEEE Canadian Review-Spring/Printemps 2002, pp. 21-24.

For clarity, when the text of this document refers to H.26L or MPEG4 part 10 or H.264, the text is meant to refer to the same class of currently emerging video coding standards.

BRIEF DESCRIPTION OF THE DRAWING

The invention is explained in further detail, by way of example and with reference to the accompanying drawing wherein:

Figs. 1 and 2 are block diagrams of systems in the invention.

Throughout the figures, same reference numerals indicate similar or corresponding features.

DETAILED EMBODIMENTS

Fig. 1 is a block diagram of a system 100 in the invention. Data representative of content information is supplied at an input 102. The data is subjected to a low pass and decimation filter 104 that reduces the resolution of the data received. An output of low-pass filter 104 is connected to an input of a base encoder 106. Such encoder and filter are well known in the art and do not need further discussion here. Encoder 106 supplies a base stream

108 representing the content information at a low resolution. The term "low resolution" here is meant to refer to the content in an acceptable format for being perceived when rendered, but of a relatively low quality. Base stream 108 as is can be, e.g., stored or supplied to an end-user, e.g., via a data network 110. As to the latter, base stream 108, as received via network 110 by an end-user 116, is subjected to a decoding operation in a decoder 118 and an up-sampling operation in a circuit 119 and is then rendered at a TV set 114.

The data at input 102 is also supplied to an adder 120 via a decoder stage 122 and a circuit 124 that subjects the decoded data from stage 122 to interpolation and sub-sampling operations. Circuit 124 outputs data that is compatible to the input data at input 102 with respect to subjecting it to data processing operations. For example, the data supplied by circuit 124 has the same resolution as the input data at input 102. Adder 120 then forms a linear combination of the data from circuit 124 and the data from input 102 by means of subtracting the former from the latter. The residual data is then supplied to an enhancement encoder 126 to produce a stream 128 of residual data or enhancement data. Enhancement stream 128 can be combined with base stream 108 to recreate the high resolution of the data as originally received at input 102 and is discussed next.

An end-user 130 receives both base stream 108 and enhancement stream 128. Enhancement stream 128 is decoded by an enhancement decoder 132, whose output is coupled to an adder 134. Base stream 108 gets decoded in a decoder 136 and is made compatible with the decoded enhancement data by a circuit 138 that carries out interpolation and up-sampling operations. The output of circuit 138 is coupled to adder 134 as well. Adder 134 combines the decoded base stream data and decoded enhancement stream data for being rendered at, e.g., a TV 140 that is suitable for rendering the high-resolution or enhanced content.

The enhancement data typically represents pixels whose values are concentrated around zero. Accordingly, if the range of pixel values of the enhancement data is transformed into a range of values compatible with those of the base data, standard electronic encoding and decoding components can be used in enhancement encoder 126 and decoder 132. Therefore, a modification unit 142 is used to add a DC offset to the pixel values supplied to encoder 126, and a modification unit 144 is used to subtract the DC offset from data received from decoder 132.

In the invention, encoder 106, and decoders 118 and 136 use a coding technique based on a conventional standard, e.g., MPEG-2, whereas encoder 126 and decoder 132 use a coding technique based on an emerging standard, e.g., H.26L. User 116 is capable

of rendering content supplied in the conventional standard. User 130 is capable of rendering content encoded in the conventional standard, plus content encoded in a multi-layer scheme using a combination of the conventional standard and the emerging standard as explained above. A service provider migrating from the conventional standard to the emerging standard may decide to use the hybrid encoding scheme for base and enhancement streams as discussed above. An advantage of this scheme is that the channel capacity allocated to this provider gets content to both users 116 and 130, both being enabled to render the content received, without the provider having to transmit the complete content once in the conventional standard and once in the emerging standard. A further advantage is that user 130 can keep on using his/her equipment after the provider has made the full transition to the new standard. In this manner, the time scale of providers switching to a new standard is more or less made compatible with the time scale of customers or subscribers renewing their equipment. The hybrid equipment of user 130 therefore enables him/her to keep on receiving content while bridging the transition period and to receive content after the new standard has been established. After the provider has stopped supplying content in the conventional, now obsolete, standard and has begun to supply content 146 in the new standard, the data follows the path as marked in the drawing in bold lines. Encoder 126 and decoder 132 are then re-used to encode and decode, respectively, the complete content. Also note that the input of the rendering apparatus, here TV set 140, is to be switched to the proper path using a switch 148. Control of switch 148 is, e.g., explicit by means of the equipment of user 130 receiving control data, e.g., via path 146 or by means of the user him/herself flipping a switch upon receipt of a notification. Control of switch 148 can also be done implicitly, namely upon the equipment of user 130 detecting an absence of base stream 108.

Fig. 1 illustrates the base stream and enhancement stream as separate items at both the transmission side and the receiver side. Note that such streams can be physically represented in the same transport stream or program stream. Decoders 118, 122, and 136 can, but need not be identical circuits. Similarly, up-sampling circuits 124 and 138 are preferably identical or have preferably identical behavior. The coding schemes of base codecs 106, 118, 122 and 136 include, e.g., MPEG-2, MPEG-4, H.261, H.263, or another conventional standard supported by a large enough installed base of receivers, i.e., the addressable market, in order to be commercially relevant to the service provider. On the other hand, codecs 126 and 132 use an emerging standard, e.g., H.26L, that is to supersede the conventional standard as it provides a lower bit rate for a given picture quality or that has other advantages over the latter.

TV sets 114 and 140 each comprise, e.g., a digital TV set based on, e.g., the SDTV (Standard Definition Television) format. SDTV is a digital television (DTV) format that ensures an image quality similar to that from a DVD.

A similar scenario along the lines sketched out above is advantageous in a transition phase from the SDTV display format to, e.g., the HDTV (high-definition TV) display format, the latter providing a higher resolution. A DTV channel first supplies SDTV in a base layer in MPEG2 and an HDTV enhancement layer in H264. A user of an SDTV set and a user of a combination of an HDTV set plus a hybrid decoder as shown in component 130 are then both enabled to receive and render the broadcast. After the market has transferred to equipment (TV sets and STB or other receivers) compliant with the HDTV-format, the broadcast can be made single-layer H264.

Above examples relate to content supplied via a data network. Fig. 2 is a block diagram of a system 200 in the invention illustrating that the same concept also applies to content supplied recorded on a physical record carrier, e.g., a solid state memory, an optical disk, a magnetic disk, etc.

System 200 comprises components of end user 130 as discussed under Fig. 1. System 200 further comprises in this example a reader and control circuit 202 that enables user 130 to render content supplied on an optical disk 204 and encoded in a hybrid scheme. The content comprises a base layer 206 encoded using a first technique and an enhancement layer 208 encoded in a second technique different from the first. Again, the first technique may relate to a conventional standard and the second technique to an emerging standard as discussed under Fig. 1. Circuit 202 reads out the data as a base stream 210 and enhancement stream 212 and supplies the data to the proper ones of decoders 132 and 136 as discussed above. Circuit 202 is further capable of processing content data supplied on a disk 214 that is entirely encoded in the second technique. Control data may be stored on disk 214 to control switch 148, or to generate a notification message to be rendered on TV set 140 so as to notify the user of switching the operational mode of his/her equipment.

It should be clear that another proper rendering device can be used instead of a TV set as illustrated in the drawing, without deviating from the scope of the invention. It should also be clear that the field of the invention is not limited to video data, but applies in general to all kinds of content including audio, graphics, video, multimedia, etc. It is also clear that what has been described above with regard to the transition from a conventional standard to an emerging standard may also apply to a transition from any standard to another standard.

Incorporated by reference herein are the following patent documents:

- Unpublished International Application no. PCT/IB02/04395 (attorney docket NL 021039) filed Oct.21, 2002, for Fons Bruls for SPATIAL SCALABLE COMPRESSION. This document relates to an apparatus and a method for performing spatial scalable compression of video information captured in a plurality of frames. A base layer encoder uses a first coding standard to encode a bitstream. An enhancement layer encoder uses a second coding standard, different from the first, to encode a residual signal. The residual signal is the difference between the original frames and the upscaled frames from the base layer.

- Unpublished International Application no. PCT/IB02/04373 (attorney docket NL 021040) filed Oct. 21, 2002, for Fons Bruls and Rene Klein Gunnewiek for DC OFFSET IN FRONT OF ENHANCEMENT CODER. This document relates to spatial scalable compression of video. Base layer encoding provides a bitstream with a relatively low resolution. Enhancement layer encoding encodes a residual signal for providing a second bitstream. A modification is provided prior to the enhancement layer encoding for transforming the residual signal into a signal with a level range of a normal input video signal.

- Unpublished International Application no. PCT/IB02/04389 (attorney docket NL 021041) filed Oct. 21, 2002, for Rene Klein Gunnewiek and Fons Bruls for INCREASING EFFICIENCY OF SPATIAL SCALABLE CODING. This document relates to a method and an apparatus for providing spatial scalable compression using adaptive content filtering of a video stream. The video stream is downsampled to reduce the resolution of the video stream. The downsampled video stream is encoded to produce a base stream. The base stream is decoded and upconverted to produce a reconstructed video stream. The reconstructed video stream is subtracted from the video stream to produce a residual stream. The resulting residual stream is encoded in an enhancement encoder and outputs an enhancement stream. The residual signal in selected frames is muted in the enhancement encoder while the motion information in the frame is maintained.

- Unpublished International Application no. PCT/IB02/04370 (attorney docket NL 021042) filed Oct. 21, 2002, for Fons Bruls and Rene Klein Gunnewiek for INCREASING EFFICIENCY FOR SPATIAL SCALABLE CODING. This document relates to an apparatus for efficiently performing spatial scalable compression of an input video stream. A base encoder encodes a base encoder stream. Modifying means modifies content of the base encoder stream to create a plurality of base streams. An enhancement encoder

encodes an enhancement encoder stream. Modifying means modifies content of the enhancement encoder stream to create a plurality of enhancement streams.

- U.S. ser.no. 09/521,051 (attorney docket US 000052) filed March 8, 2000, for Geert Bruynsteen for BUSINESS MODEL FOR LEASING STORAGE SPACE ON A DIGITAL RECORDER, published under PCT as International Application WO0167743. This patent document relates to adjusting, via a data network, the available amount of storage space of a fixed HDD on a CE device. The consumer can upgrade the device via a third party service that remotely control's the HDD's settings.

Similarly, various compression algorithms associated with respective upgrades can be remotely enabled by the manufacturer, the dealer or the content provider.